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Konchan et al.

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(54) **ELECTRICAL CONNECTOR ASSEMBLY**

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H01R 13/703	(2006.01)

(52) **U.S. Cl.**

CPC ***H01R 13/6278*** (2013.01); ***H01R 13/6272*** (2013.01); ***H01R 13/703*** (2013.01); ***H01R 43/26*** (2013.01)

(58) **Field of Classification Search**

CPC H01R 13/6272; H01R 13/6273; H01R 13/6275; H01R 13/639; H01R 13/627

USPC 439/358

See application file for complete search history.

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(57) **ABSTRACT**

An electrical connector assembly including a first connector having a first electrical conductor. A second connector is engagable with the first connector and has a second electrical conductor. The first and second electrical conductors establish an electrical connection through the electrical connector assembly when in contact together. A lock mechanism is arranged to both lock the first and second connectors together and to enable contact between the first and second conductors when the first and second connectors are in a fully engaged relation. A method of establishing an electrical connection through an electrical connector assembly is also included.

15 Claims, 4 Drawing Sheets

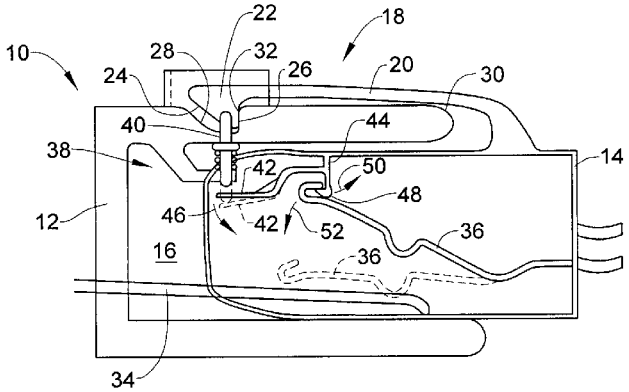

FIG. 1

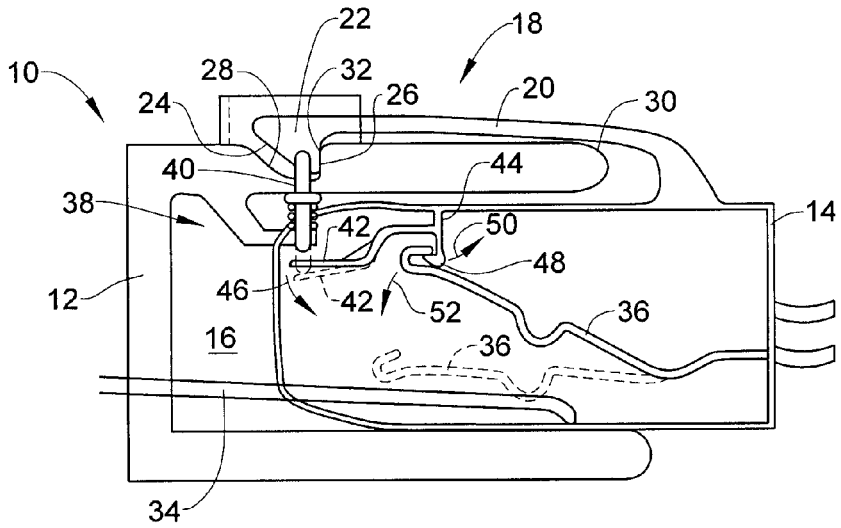
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FIG. 2

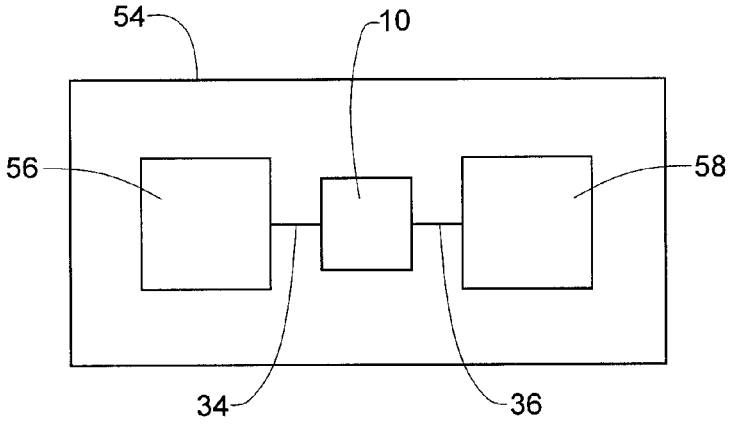
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FIG. 3

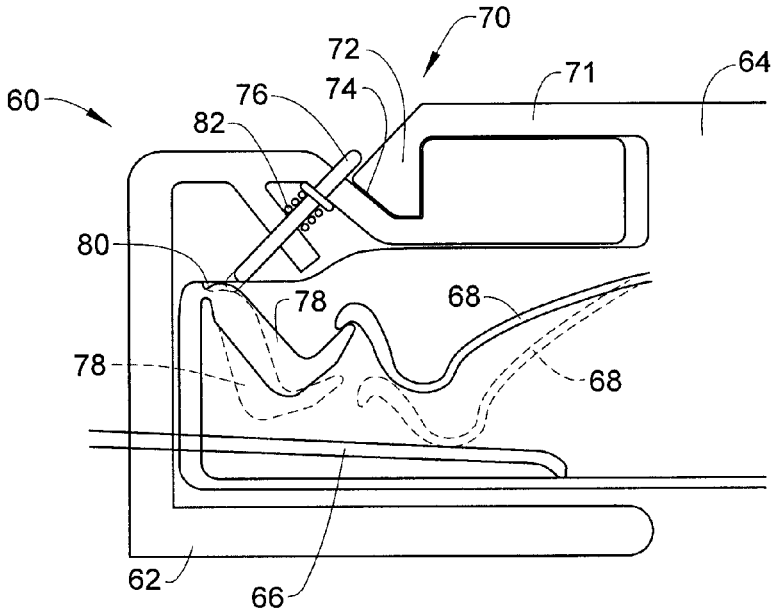
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FIG. 4

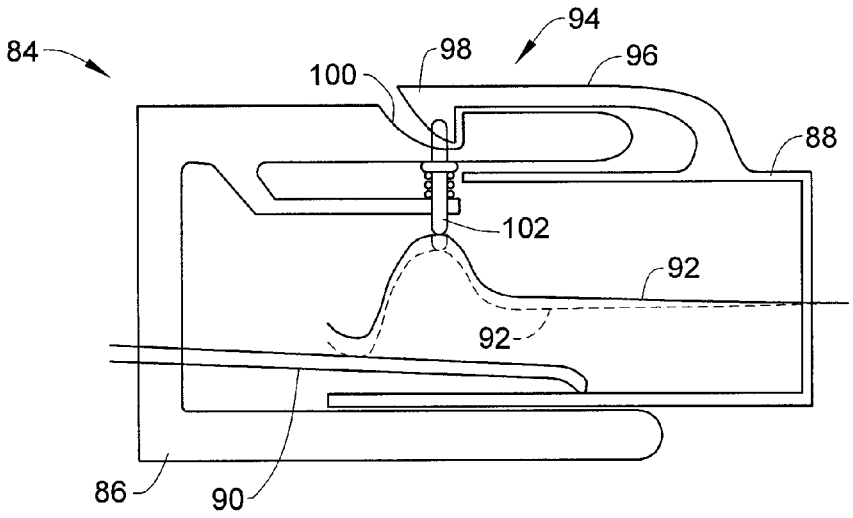
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FIG. 5

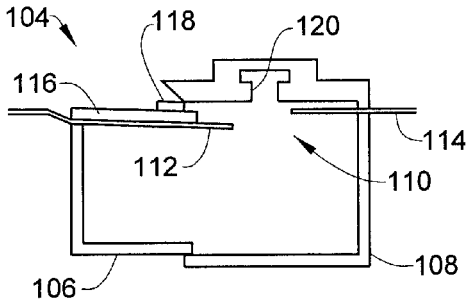

FIG. 6

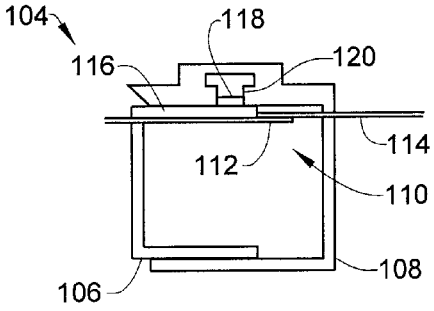

FIG. 7

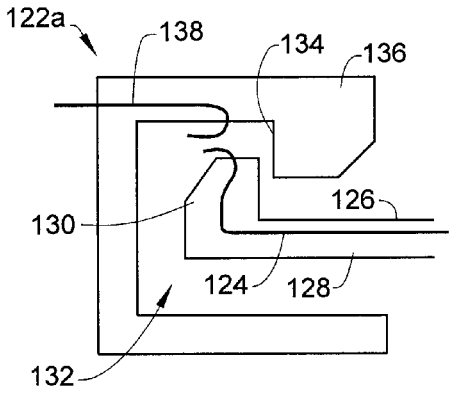

FIG. 8

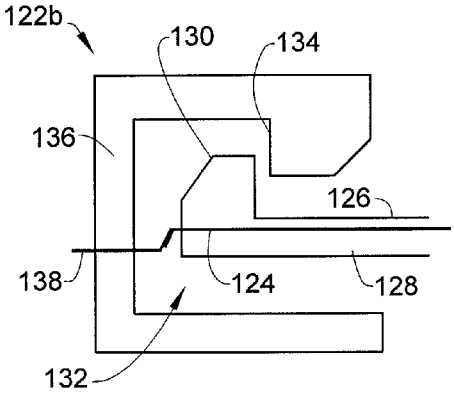

FIG. 9

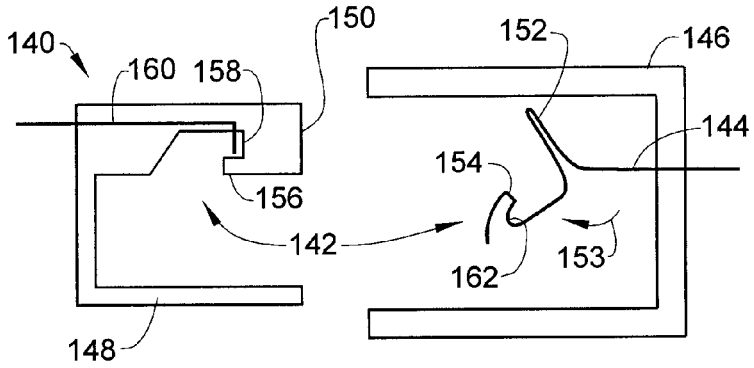
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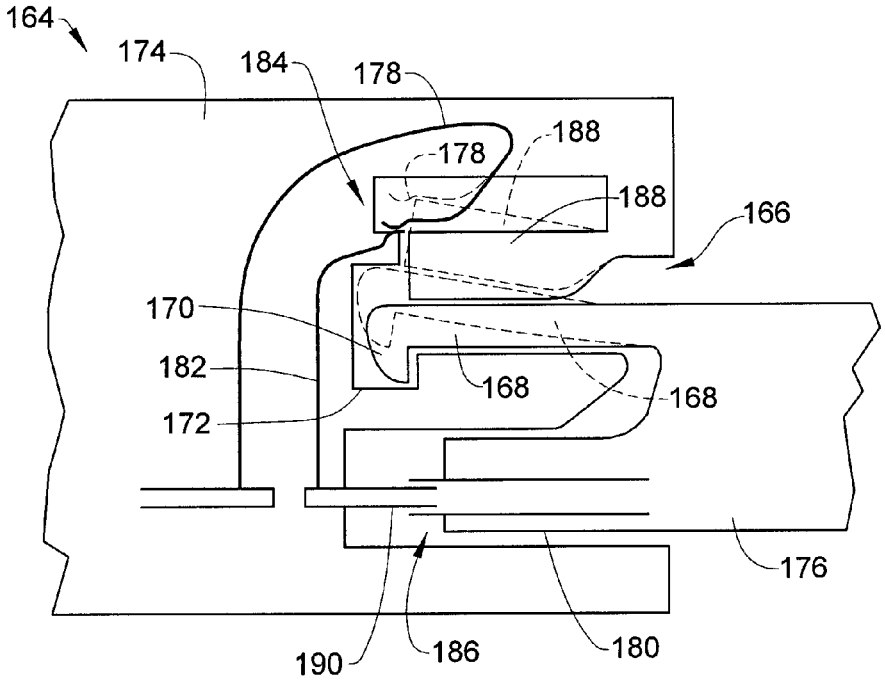
FIG. 10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ELECTRICAL CONNECTOR ASSEMBLY

FIELD OF THE INVENTION

The subject invention relates to an electrical connector and, in particular, an electrical connector having a positive mechanical connection.

BACKGROUND

Electrical connector assemblies are used in a variety of industries including the automotive industry. Each assembly may include two or more connectors, e.g., a male portion and a female portion, a plug and a receptacle, etc., that form an electrical connection when physically engaged together. These assemblies can be equipped with a locking or latching mechanism to limit relative movement of the connectors after physical engagement thereof in order to prevent undesired disruption of the electrical connection. The reliability and verifiability of the lock mechanism are thus important in establishing a long lasting electrical connection that will not readily become disengaged over time or during use of the connector assembly.

Accordingly, it is desirable to provide an electrical connector assembly that reliably and/or verifiably forms a mechanical connection between two electrical connectors.

SUMMARY OF THE INVENTION

In one exemplary embodiment of the invention, an electrical connector assembly is provided. The electrical connector assembly includes a first connector having a first electrical conductor and a second connector engagable with the first connector that has a second electrical conductor. The first and second electrical conductors establish an electrical connection through the electrical connector assembly when in contact together. A lock mechanism is arranged to both mechanically lock the first and second connectors together and to enable contact between the first and second conductors when the first and second connectors are in a fully engaged relation.

In another exemplary embodiment of the invention, a method of establishing an electrical connection through an electrical connector assembly is provided. The method includes moving a first connector and a second connector of the electrical connector assembly together to engage the first and second connectors. Contact is prevented between a first conductor of the first connector and a second conductor of the second connector during the moving. The first and second connectors are mechanically locked together with a lock mechanism when the first and second connectors are moved to a fully engaged relation. Contact is enabled between the first and second connectors with the lock mechanism due to the locking. Electrical communication is performed through the electrical connector assembly.

The above features and advantages and other features and advantages of the invention are readily apparent from the following detailed description of the invention when taken in connection with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Other features, advantages and details appear, by way of example only, in the following detailed description of embodiments, the detailed description referring to the drawings in which:

FIG. **1** is a cross-sectional view of an electrical connector assembly according to one embodiment disclosed herein;

FIG. **2** is schematically illustrates an automobile including the electrical connector assembly of FIG. **1**; and

FIGS. **3-10** illustrate electrical connector assemblies according to various embodiments disclosed herein.

DESCRIPTION OF THE EMBODIMENTS

The following description is merely exemplary in nature and is not intended to limit the present disclosure, its application or uses. It should be understood that throughout the drawings, corresponding reference numerals indicate like or corresponding parts and features.

In accordance with an exemplary embodiment of the invention, and with reference to FIG. **1**, an electrical connector assembly **10** is provided. The electrical connector assembly **10** includes a first connector **12** and a second connector **14**. The first connector **12** has an internal cavity **16** arranged to receive the second connector **14** therein. To this end, the first connector **12** may be alternatively or colloquially referred to as a socket, receptacle, or female connector, while the second connector **14** may be alternatively or colloquially referred to as a plug or male connector.

A lock mechanism **18** is included between the connectors **12** and **14** to mechanically and/or physically latch, lock, fasten, secure, or otherwise prevent relative movement between the connectors **12** and **14** when the connectors **12** and **14** are fully engaged together, that is, moved together into a fully engaged relation. In the illustrated embodiment, the mechanism **18** includes a resilient arm **20** extending from the connector **14** that terminates in a projection, protrusion, or head **22**. The projection **22** includes a ramped or angled surface **24** and a locking surface **26**. The connector **12** includes a notch, groove, step, shoulder, or recess **28** (generally, "notch") for receiving the projection **22** when the connectors **12** and **14** are fully engaged. To this end, the arm **20** can be, and/or represents, any suitable hinged, springing, resilient, and/or cantilevered beam, rod, bar, strip, filament, etc. that enables the projection **22** to progressively "climb" a ramped or angled surface **30** of the connector **12** and then drop or snap the projection **22** into the notch **28** when aligned therewith. The resiliency of the arm **20** can also be provided by a separate biasing element, e.g., a spring or resilient material disposed with the arm **20**.

The notch **28** has a shoulder **32** that is oriented substantially parallel to the locking surface **26**. In this way, relative movement between the connectors **12** and **14** is limited by mating engagement of the surface **26** with the shoulder **32** when the projection **22** is located within the notch **28**. It is noted that a user can manually manipulate lock mechanism **18** to release the connectors **12** and **14**, e.g., by first lifting the projection **22** out of the notch **28** and then disengaging the connectors **12** and **14** by moving the connectors **12** and **14** apart.

The connector **12** has a first conductor **34** and the connector **14** has a second conductor **36**, such that contact between the first and second conductors **34** and **36** establishes an electrical connection between the connectors **12** and **14**. The conductors **34** and/or **36** can be arranged as blades, wires, etc., or other structures made from or including electrically conductive materials, e.g., metal. Advantageously, the conductors **34** and **36** are prevented from contacting until the connectors **12** and **14** are fully engaged and locked by the lock mechanism **18**. In other words, the lock mechanism **18** is arranged to both enable contact to be made between the conductors **34** and **36**, and to physically lock the connectors **12** and **14** together when the connectors **12** and **14** are moved into a fully engaged relation. In this way, electrical inspection of the connection

formed through the assembly **10** also verifies that the connectors **12** and **14** are fully engaged and locked together.

Specifically with respect to the illustrated embodiment, the lock mechanism **18** enables electrical connection through the connector assembly **10** by actuating a contactor device **38**. In the illustrated embodiment, actuation of the contactor device **38** is accomplished by the projection **22** depressing a plunger **40** or other actuator when the projection **22** is snapped or driven into the notch **28**, e.g., due to the resiliency and/or spring-like nature of the arm **20**. The plunger **40** in turn presses a lever **42**, thereby causing the lever **42** to rotate about a hinge or pivot section **44**. The rotation of the lever **42** is generally identified by an arrow **46**. Actuation of the lever **42**, e.g., rotation of the lever **42** about the hinge section **44**, results in a corresponding actuation of a finger **48** of the contactor device **38**. For example, rotation of the finger **48** due to actuation of the lever **42** in the illustrated embodiment is represented by an arrow **50**. The rotation or other actuation of the finger **48** causes the contactor device **38**, namely the finger **48** of the contactor device **38**, to release the conductor **36**. The conductor **36** can be resilient, spring-like, or otherwise arranged to move into contact with the conductor **34** when released by the contactor device **38**, as indicated by an arrow **52**. The resilient movement can also be provided by a separate biasing element, e.g., a spring or resilient material disposed with the conductor **34**. Dashed lines are included to represent the conductor **36**, the plunger **40**, and the lever **42** when in the actuated configuration.

The assembly **10** (and other assemblies discussed herein below) is generally applicable to any industry in which electrical connections must be made between pairs of electrical components. The assembly **10** (and other embodiments disclosed herein) imparts particular benefits to electrical connector assemblies that are subject to constant vibration or long periods of loading, positioned in locations that are difficult to access, etc., such as the automotive industry. Accordingly, FIG. **2** schematically illustrates an automobile **54** including the assembly **10** in order to establish an electrical connection between a first component **56** and a second component **58**. The first and second components **56** and **58** can be any two components requiring an electrical connection, i.e., electrical communication, therebetween. As shown, the first component **56** is electrically coupled to the assembly **10** via the conductor **34** and the second component **58** is electrically coupled to the assembly **10** via the conductor **36**. The terms electrical connection, electrically coupled, and electrical communication are meant to be generally interchangeable and include the ability to communicate power, signals, and/or data electrically. For example, in one specific non-limiting embodiment, the first component **56** is a power lock mechanism for a door of the automobile **54** and the second component **58** is a power source, a switch, a button, and/or a trigger for powering and/or controlling actuation of the power lock mechanism. Any number of pairs of electrical components can be coupled together via the assembly **10**. Advantageously, a standard test of the proper functionality of the electrical components of the automobile **54** will also verify that all of the assemblies **10** are mechanically locked, as contact between the conductors **34** and **36** is prevented until the lock mechanism **18** has locked the connectors **12** and **14** together, whereas an electrical inspection cannot be relied upon to indicate a locked status between connectors in previously known connector assemblies. Those of ordinary skill in the art will recognize a myriad of electrical components both within and outside of the automotive industry that can be connected by and benefit from the embodiments disclosed herein.

It is of course to be understood that the lock mechanisms and/or contactor devices of electrical connector assemblies can take forms other than that illustrated in FIG. **1**, which also act to initially prevent and then selectively permit, enable, or establish contact between a pair of conductors in response to the lock mechanism assuming locked engagement between corresponding connectors of the assemblies. Several non-limiting examples are provided in FIGS. **3-10** and described below. It is thus to be appreciated that the embodiments of FIGS. **3-10** can be used generally in lieu of the assembly **10**, e.g., within the automobile **54**, or for electrically connecting any two electrical components.

FIG. **3** illustrates an assembly **60** that is similar to the assembly **10** in many respects, e.g., including a first connector **62** that is arranged to receive a second connector **64** in order to establish an electrical connection between a first conductor **66** and a second conductor **68** respectively thereof. The assembly **60** includes a lock mechanism **70** that similarly includes a resilient arm **71** terminating in a projection **72**, which is located within a notch **74** in order to lock the connectors **62** and **64** together when the connectors **62** and **64** are fully engaged. As the projection **72** is urged into the notch **74**, a plunger **76** is depressed in order to actuate a lever **78** by rotating the lever **78** at a hinge **80**. Rotation of the lever **78** about the hinge **80** causes the lever **78** to release the conductor **68**, such that the conductor **68** can move into contact with the conductor **66**. Dashed lines are provided to illustrate the lever **78** and the conductor **68** in the actuated/released configuration. Unlike the plunger **40** of the assembly **10**, the plunger **80** is able to return to its initial position, e.g., under the influence of a spring **82** or other biasing element. When returned to its initial position, the plunger **80** assists in locking the connectors **62** and **64** together by presenting a further obstacle that prevents the projection **72** from exiting engagement within the notch **74**.

An assembly **84** is depicted in FIG. **4**, including a first connector **86** and a second connector **88**, having a first conductor **90** and a second conductor **92**, respectively. A lock mechanism **94** is included having a resilient arm **96** and a projection **98** that is engagable in a notch **100** in order to lock the connectors **86** and **88** together. Engagement of the projection **98** in the notch **100** causes the projection **98** to actuate a plunger **102**. When actuated, the plunger **102** presses the conductor **92** into contact with the conductor **90**. Unlike the embodiments of FIGS. **1** and **3**, the lock mechanism **94** does not cause release of the conductor **92**, but instead actively holds the conductor **92** against the conductor **90** as long as the lock mechanism **94** is locking the connectors **86** and **88** together.

FIGS. **5** and **6** depict an assembly **104** having a first connector **106** and a second connector **108** arranged in a disengaged and a fully engaged, locked configuration, respectively. That is, when the first and second connectors **106** and **108** are fully engaged together, as shown in FIG. **6**, a lock mechanism **110** brings a first conductor **112** of the first connector **106** and a second conductor **114** of the second connector **108** into contact in order to establish an electrical connection through the assembly **104**. The lock mechanism **110** includes a resilient arm **116** terminating in a projection **118**. The projection **118** is arranged to displace the conductor **112** away from possible contact with the conductor **114** until the projection **118** enters a notch **120**. The conductor **112** can be affixed to the arm **116**, resiliently disposed against the arm **116**, etc., in order to provide contact with the conductor **114** when the projection **118** enters the notch **120**.

FIGS. **7** and **8** depict a pair of similar assemblies, designated **122***a* and **122***b* (collectively "the assemblies **122**"),

respectively, which are shown only in part. The assemblies **122** each include a first conductor **124** of a first connector **126** that is formed directly within and/or through a resilient arm **128** and a projection **130** of a lock mechanism **132**. The projection **130**, similar to the projections discussed in the embodiments above, is received within a notch **134** in order to lock the connector **126** to a second connector **136**. When the projection **130** is located within the notch **134**, the conductor **124** is brought into contact with a second conductor **138** in order to establish an electrical connection through the assemblies **122**.

An assembly **140** is depicted in FIG. **9** in which a lock assembly **142** is formed in part by a first conductor **144** of a first connector **146**. When the first connector **146** is moved into a fully engaged relation with a second connector **148**, a shoulder **150** of the connector **148** will press against a lever **152** formed by, or connected to, the conductor **144**. Pressing the shoulder **150** against the lever **152** will rotate the lever **152** as indicated by an arrow **153**. This rotation also causes a contact portion **154** of the conductor **144** to rotate about a lip **156** of the connector **148**, thereby positioning the contact portion **154** in a notch **158** in contact with a second conductor **160** of the second connector **148**. The rotation, e.g., as indicated by the arrow **153**, also positions the lip **156** within a notch **162** of the conductor **144**. Once so positioned, the connectors **146** and **148** are effectively locked together by engagement of the contact portion **154** and the lip **156** with their respective notches **158** and **162** and the shoulder **150** being positioned or trapped between the lever **152** and the contact portion **154** of the conductor **144**.

FIG. **10** illustrates an assembly **164** according to yet another embodiment disclosed herein. The assembly **164**, similar to several embodiment discussed above, includes a lock mechanism **166** comprising a resilient arm **168** having a projection **170** thereon. The projection **170** is arranged to engage within a notch **172** in order to lock a first connector **174** and a second connector **176** together. The first connector **174** includes a first conductor **178** and the second connector **176** includes a second conductor **180**. Unlike the other embodiments disclosed herein, a third or intermediate conductor **182** is provided. An electrical connection through the assembly **164** is not established until contact is made at both a first interface **184** between the first conductor **178** and the intermediate conductor **182** and at a second interface **186** between the second conductor **180** and the intermediate conductor **182**. In other words, contact between the first conductor **178** and the second conductor **180** is established indirectly via contact of both of the conductors **178** and **180** with the intermediate conductor **182**. In this way, the intermediate conductor **182** essentially acts as an extension of the first conductor **178** and/or the second conductors **180**.

When the connectors **174** and **176** are moved together, but before the projection **170** is located within the notch **172**, the projection **170** will cause the arm **168** to press against a lever **188**. Actuation of the lever **188** displaces the first conductor **178** from the intermediate conductor **182** at the interface **184**. Thus, even if contact is made at the interface **186**, e.g., by the second conductor **180** engaging a stub **190** of the intermediate conductor **182**, the actuation of the lever **188** by the lock mechanism **166** will disrupt contact at the first interface **184**. Contact between the first and second conductors **178** and **180** is thus not possible until contact is separately made at both the interfaces **184** and **186**, which only occurs after the projection **170** engages the notch **172**, thereby releasing the lever **188** to return to its initial position and establish contact at the first interface **184**.

It is again to be appreciated that the illustrated embodiments represent various non-limiting examples that include a lock mechanism that both locks together two connectors of an electrical connector assembly and enables contact between two conductors thereof in order to establish an electrical connection through the assembly. It is noted that features of the various illustrated embodiments can be combined together or interchanged, or otherwise utilized with non-illustrated features, whether piecemeal or in combination, to form yet further embodiments without departing from the intended scope of the invention.

While the invention has been described with reference to exemplary embodiments, it will be understood by those skilled in the art that various changes may be made and equivalents may be substituted for elements thereof without departing from the scope of the invention. In addition, many modifications may be made to adapt a particular situation or material to the teachings of the invention without departing from the essential scope thereof. Therefore, it is intended that the invention not be limited to the particular embodiments disclosed, but that the invention will include all embodiments falling within the scope of the application.

What is claimed is:

1. An electrical connector assembly comprising:
- a first housing;
- a first connector coupled to the first housing and having a first electrical conductor, the first electrical conductor being resiliently movable from a first position to a second position;
- a second housing;
- a second connector coupled to the second housing and having a second electrical conductor, the first and second electrical conductors establishing an electrical connection through the electrical connector assembly when in contact together; and
- a lock mechanism that is arranged to mechanically lock the first housing and the second housing together and to release the first conductor from the first position to resiliently move into the second position in contact with the second conductor when the first housing and second housing are in a fully locked position, wherein the lock mechanism includes a resilient arm having a projection thereon and a notch arranged to receive the projection in order to lock the first and second connectors together;
- wherein at least one of the first or second conductors is coupled to the resilient arm, the projection, or a combination including at least one of the foregoing.

2. The electrical connector assembly of claim **1**, wherein the first and second connectors together comprise a male connector and a female connector.

3. The electrical connector assembly of claim **1**, wherein the lock mechanism is arranged to press the first and second conductors together.

4. An electrical connector assembly comprising
- a first connector having a first electrical conductor;
- a second connector engagable with the first connector and having a second electrical conductor, the first and second electrical conductors establishing an electrical connection through the electrical connector assembly when in contact together;
- a lock mechanism that is arranged to both mechanically lock the first and second connectors together and to enable contact between the first and second conductors when the first and second connectors are in a fully engaged relation, wherein the lock mechanism includes a resilient arm having a projection thereon and a notch

arranged to receive the projection in order to lock the first and second connectors together; and

wherein the projection is arranged to actuate a plunger in communication with at least one of the first or second conductors when the projection is engaged within the notch.

5. The electrical connector assembly of claim **4**, wherein the plunger presses the first and second conductors together.

6. The electrical connector assembly of claim **4**, wherein the first conductor is initially supported by a lever, the lever arranged to release the first conductor when the lever is actuated by the plunger, the first conductor arranged to move resiliently when released by the lever to contact the second conductor.

7. The electrical connector assembly of claim **4**, wherein the plunger creates a barrier preventing the projection from disengaging from the notch after the plunger is actuated by the projection.

8. The electrical connector assembly of claim **1**, wherein the at least one of the first or second conductors is disposed within or through the resilient arm, the projection, or a combination including at least one of the foregoing.

9. The electrical connector assembly of claim **1**, further comprising an intermediate conductor selectively engaging the first and second conductors in response to the first connector and the second connector being in a fully engaged relation.

10. The electrical connector assembly of claim **9**, wherein the projection is arranged to press the resilient arm against a lever until the projection is located within the notch in order to actuate the lever, the lever displacing the first conductor and the intermediate conductor from each other.

11. The electrical connector assembly of claim **9**, wherein the intermediate conductor is disposed with the first connector.

12. The electrical connector assembly of claim **1**, wherein the lock mechanism is at least partially comprised by the first conductor.

13. The electrical connector assembly of claim **12**, wherein the first conductor is arranged with a contact portion, a lever, and a notch, and the second connector is arranged with a shoulder that is engagable with the lever to rotate the contact portion of the first conductor about a lip into contact with the second conductor such that the lip is positioned within the notch and the shoulder is positioned between the lever and the contact portion of the first conductor.

14. An automobile including an electrical connector assembly according to claim **1**.

15. The automobile of claim **14**, further comprising a first electrical component and a second electrical component, the first and second electrical components in electrical communication with the first and second conductors, respectively.

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